

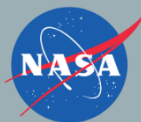
# DEVELOPMENT AND APPLICATION OF GRIDDED NUCAPS FOR OPERATIONAL FORECASTING CHALLENGES

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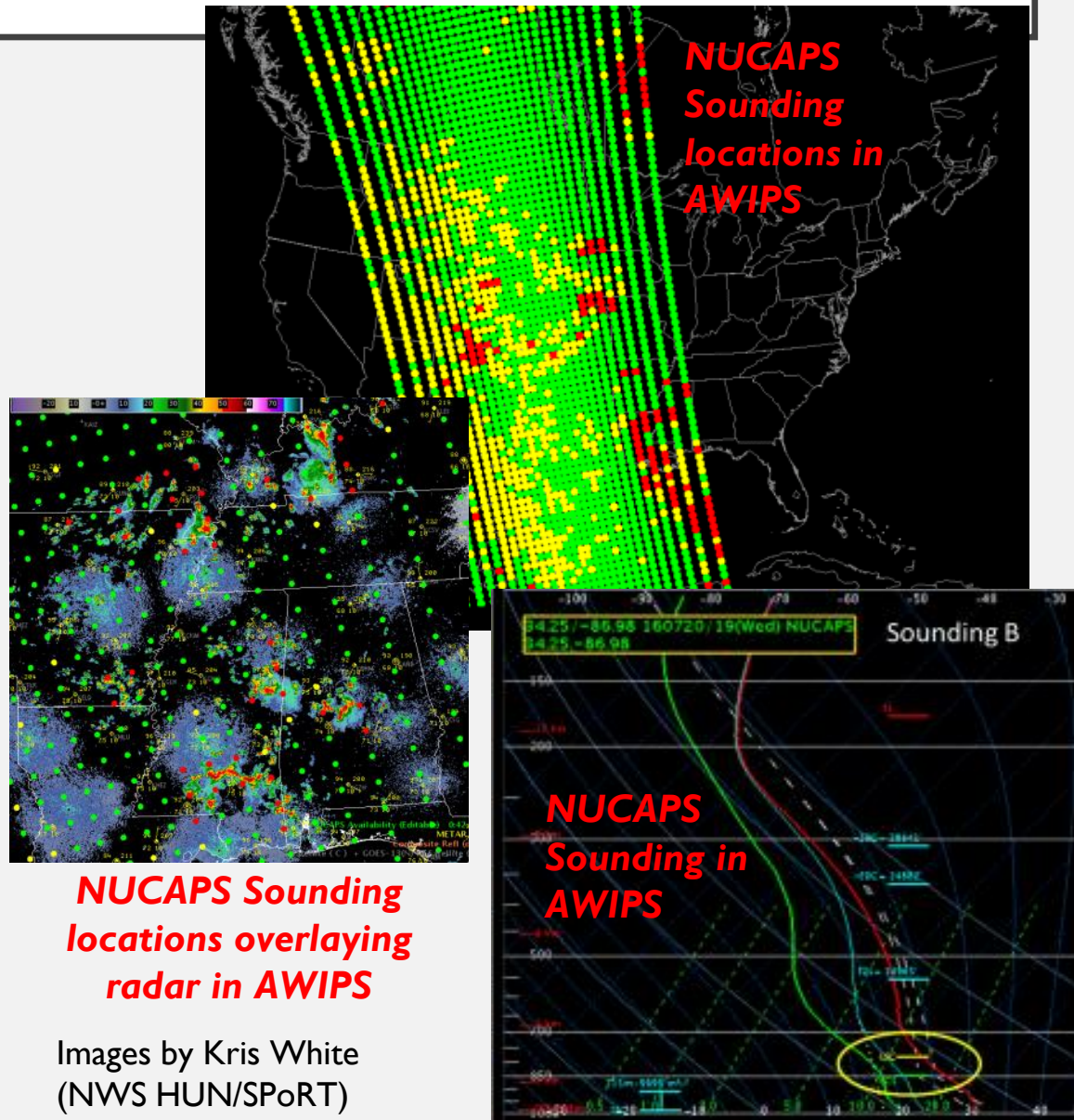
JPSS Science Seminar

23 October 2017



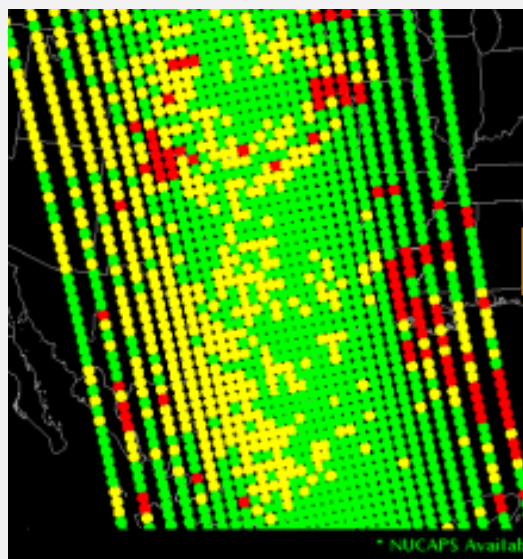
# Current Operational NUCAPS Visualization

- NUCAPS is the NOAA Operational Retrieval algorithm for SNPP CrIS/ATMS and Metop IASI/AMSU T and q profiles
- Capabilities for displaying individual Skew-T plots are available in the latest versions of AWIPS II with quality control flags
- Skew-Ts are valuable for some forecast challenges, and ***visualizing the data in plan view or cross section may be more useful for others***
- NUCAPS allows forecasters to observe the 3D extent of the atmosphere
- Helpful where conventional observations are sparse



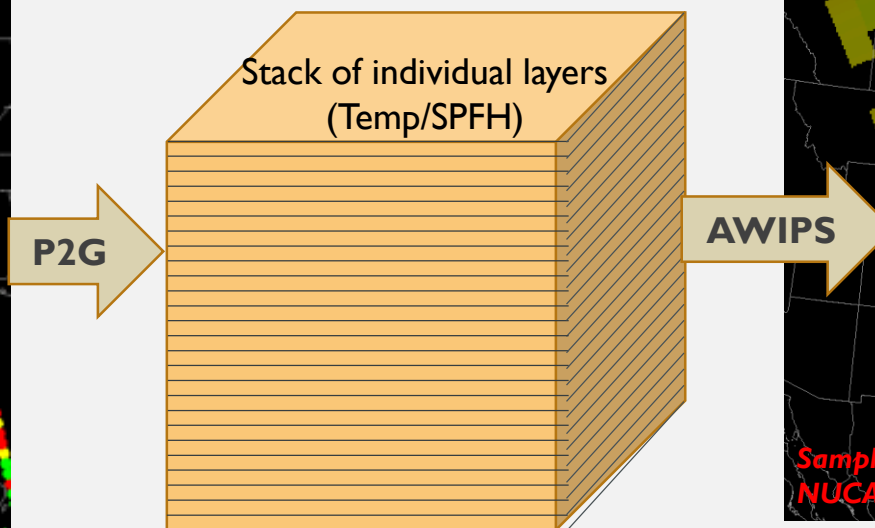
# GRIDDED PRODUCT OVERVIEW

- CIMSS has modified its polar2grid software package to include readers for NUCAPS
- SPoRT obtains Direct Broadcast data, runs polar2grid, and converts output to gridded binary (GRIB2) format for ingest into AWIPS II
- GRIB2 files are pushed to NWS partners in real-time



NUCAPS Soundings:  
Need to click on each 'point' to review the vertical information

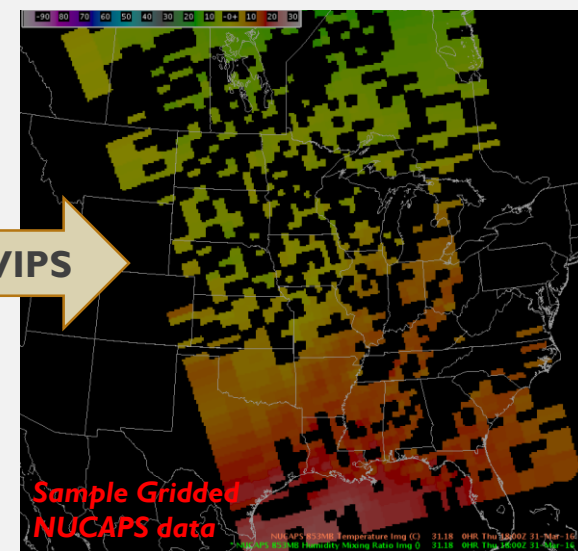
- *Pros: Can choose specific locations*
- *Cons: A lot of individual interrogation*



A subset of 58 layers are output using Polar2Grid from the 100 layers output by NUCAPS.

The grib2 file only contains:

- Temperature, Specific humidity
- Surface pressure and temperature
- Topography

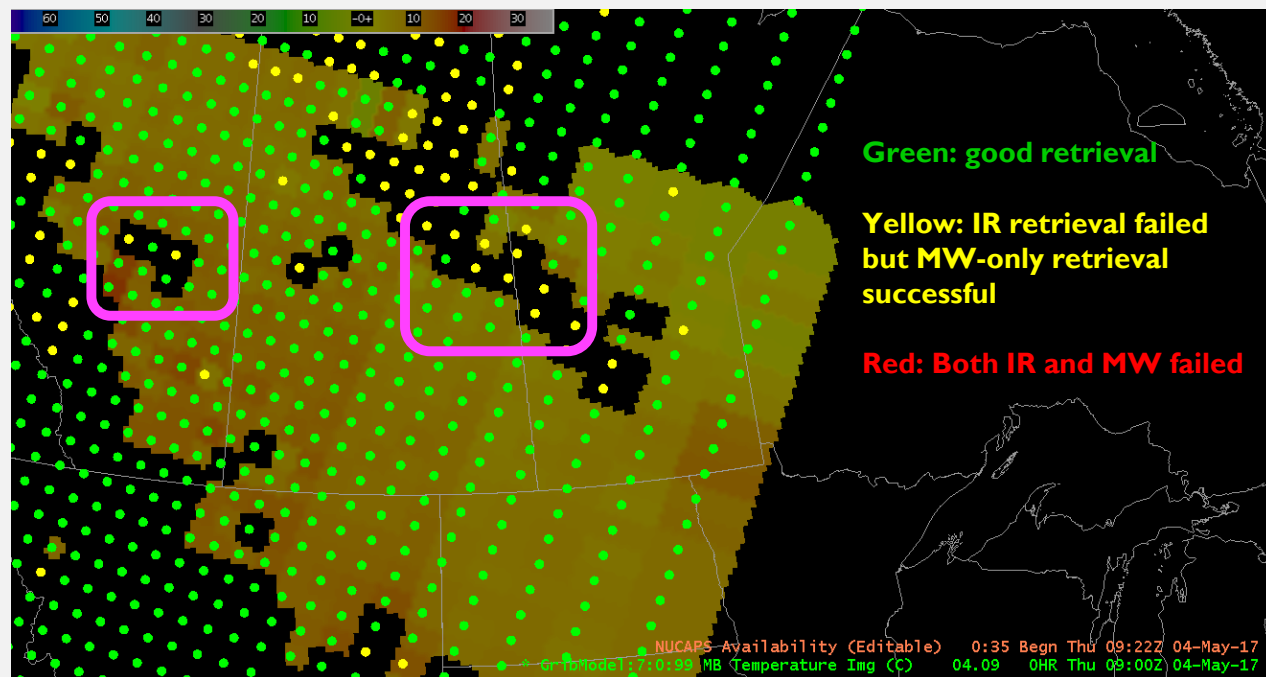


Ingested into AWIPS on a uniform model grid, so AWIPS will interrogate the information in the same way it handles model data.

- Plan view and cross sections
- Temperature, moisture, and stability indices.

# LIMITATIONS/CONS

- Gaps in gridded data due to cloud cover and failed retrievals
- Discrepancies between NUCAPS Sounding output and Gridded NUCAPS (i.e. CAPE values differ)
- Mis-match in quality flags and retrieval quality at cloud edges between operational and direct broadcast processing (only 7 of 9 CrIS FOVs processed via direct broadcast)
- Individual retrievals are not preserved (i.e. gridding results in multiple 10-12 km grid boxes inside each NUCAPS footprint)
- Infrared observations are sensitive to surface temperature
  - Land vs ocean
  - Day vs night
  - Local conditions

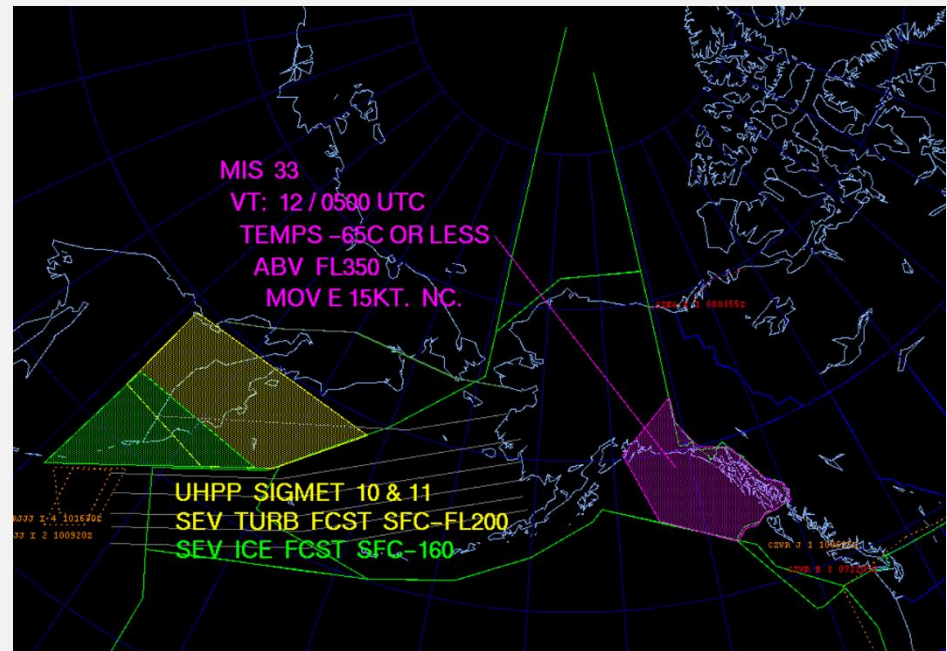




# FORECAST CHALLENGE: COLD AIR ALOFT

- Gridded NUCAPS was initially developed to address Cold Air Aloft
- Cold Air Aloft ( $\leq -65^{\circ}\text{C}$ ) events can freeze airliner fuel and regularly occur at flight levels in the arctic
- Center Weather Service Units (CWSU) provide Meteorological Impact Statements (MIS) to Air Traffic Controllers to direct flights around the 3D air features
- In data sparse Alaska, forecasters have relied on analysis and model fields and limited radiosonde observations to guess the 3D extent of the Cold Air Aloft
- Use of satellite observations provides an opportunity for forecasters to observe the 3D extent of the Cold Air Aloft in real-time

*Alaska CWSU domain (green line) and warning guide for 11 January 2017. Purple hatched area is an advisory for Cold Air Aloft*



*Example text product disseminated by Alaska CWSU for Cold Air Aloft; valid 14 November 2015*

```
FAAK20 KZAN 121458
ZAN MIS 01 VALID 121500-130300
...FOR ATC PLANNING PURPOSES ONLY...
COLD AIR ALOFT
FROM 185NE SCC-65NE ORT-55SW ENN-110NW BRW-185NE SCC
TEMPS -65C OR LESS FM FL350-400. AREA MOVG NE 40 KTS.
CMW NOV 14
```

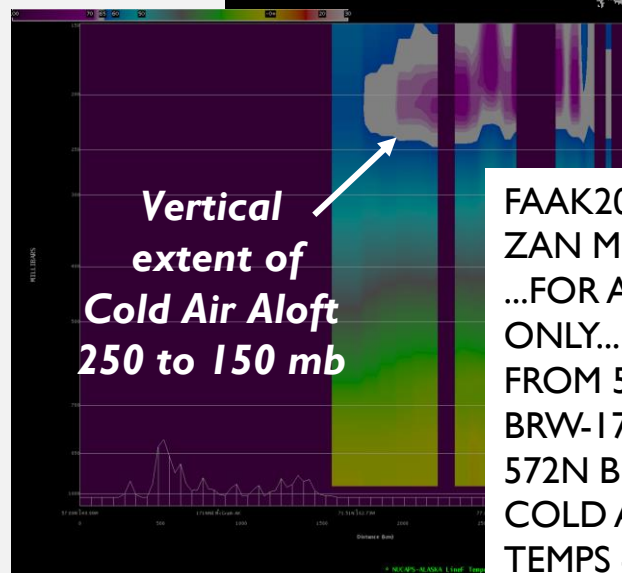
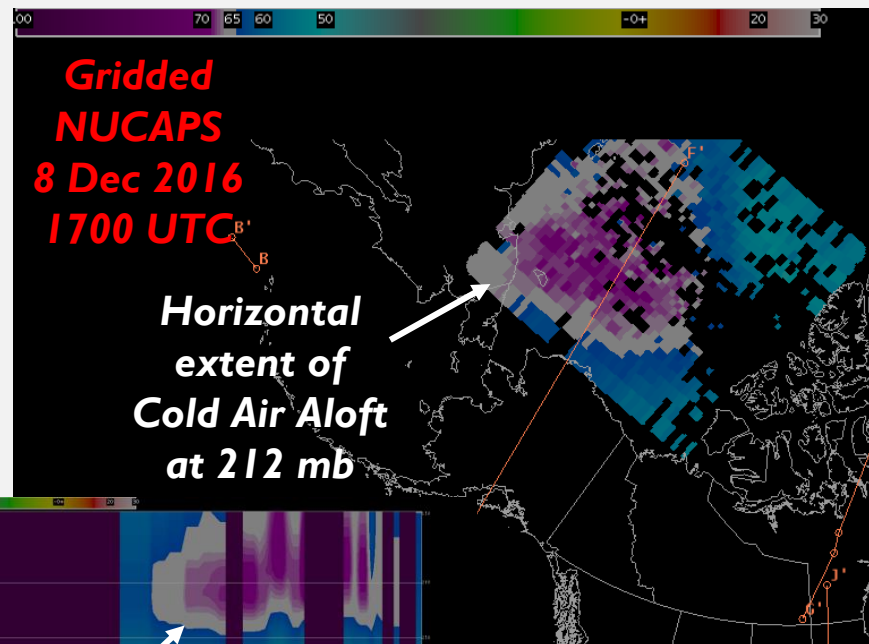
Lat/Lon Extent of Cold Air from soundings, aircraft reports, model

Vertical Extent of Cold Air from soundings/aircraft reports/model

Motion determined from model data

# PRODUCT DEMONSTRATION

- Forecasters at the Anchorage CWSU evaluated the Gridded NUCAPS during the 2016-2017 Winter
- Goal was to provide data to improve Cold Air Aloft analysis and increase confidence when issuing operational MIS statements use by the FAA and airlines.
- Preparation for the demonstration included:
  - In person visit to the CWSU to cover training material
  - A specific color curve to outline the coldest air
  - A procedure to allow forecasters to quickly toggle through the vertical layers
- Short videos to demonstrate installation and use of the data



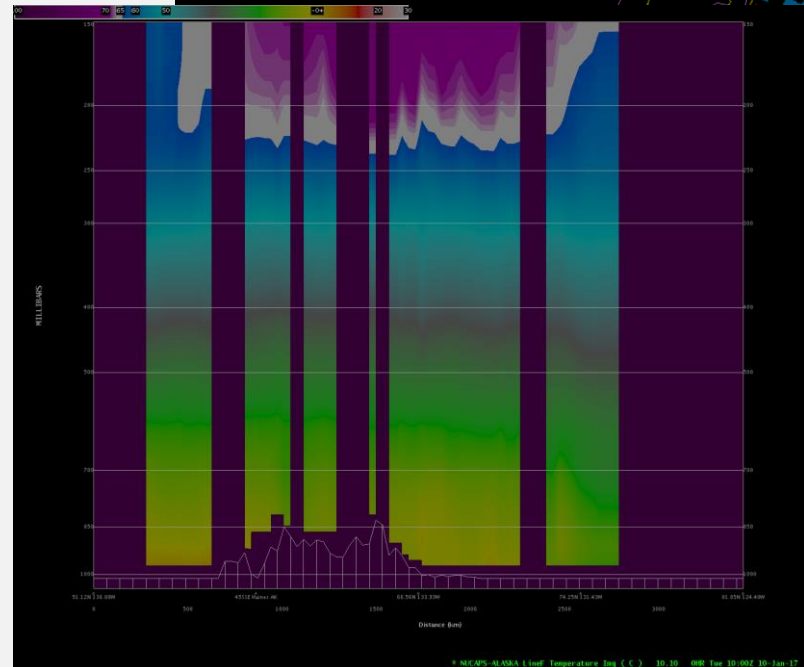
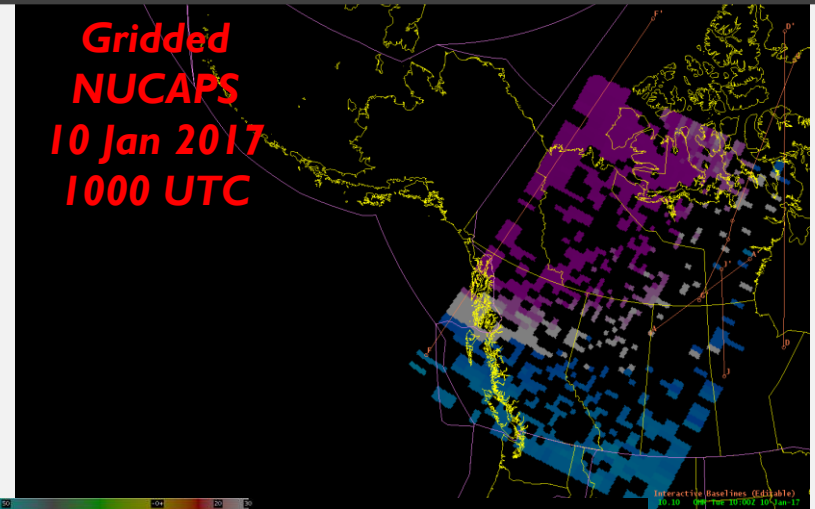
FAAK20 KZAN 082312  
ZAN MIS 01 VALID 082312-090600  
...FOR ATC PLANNING PURPOSES  
ONLY...  
FROM 575NNW BRW-510NNE  
BRW-175NE SCC-BRW-200W BRW-  
572N BRW  
COLD AIR ALOFT  
TEMPS -65C OR LESS FM FL310-  
FL340. MOV E 15 KT. INTSF.  
GMW DEC 16

# FORECASTER FEEDBACK

- 2/2/17 6:00a **Some Operational Impact, High Confidence:** “NUCAPS images on the WEB site were about 5 degrees C too cool over the eastern Bering and western Alaska compared to 12Z raobs and the NAM/GFS. **NUCAPS 12Z image on AWIPS at 212 mb was right on though with temperatures and with the models and observations.**” –unnamed AK CWSU forecaster
- 2/24/17 8:00p **Very Large Operational Impact, High Confidence:** “**Both the GFS and gridded NUCAPS showed an area of CAA moving into the central Aleutian's**, with the GFS being slightly better tonight in bringing in colder values in the same area depicted by both models. 25/00Z soundings did not help since the CAA was moving up from the south after 00Z.” – Gail Weaver, AK CWSU
- 2/28/17 2:00p **Very Large Operational Impact, High Confidence:** “I used the Gridded NUCAPS CAA heights today since the new area of CAA did not include any upper air sounding sites (it was located over the Bering Sea). The GFS model seemed to be weaker and depicted a smaller area of CAA than the NUCAPS, so **I had more confidence in the NUCAPS data today.**” –Gail Weaver, AK CWSU
- 3/1/17 8:00a **Very Large Operational Impact, High Confidence:** “GFS model data showed temps near -65C over the northern Bering Sea this morning. SYA and SNP 12Z raobs did show -65C right around FL330, but it was only about 500 feet deep. The NAM was slightly colder than the GFS in the area between and north of SYA-SNP to the FIR boundry. **Based on the SNPP-NUCAPS it showed a deeper layer, nearly 5000 feet, from FL350-FL400 in this area that was not sampled by the raobs. Due to the models trending colder the next 12-24 hours I decided to issue a MIS for Cold Air Aloft based on the Gridded NUCAPS data. I felt very confident in the NUCAPS data based on the surrounding raobs, model data, timing, and intensity of the data represented in these graphics.**” –unnamed AK CWSU forecaster

# NEXT STEPS

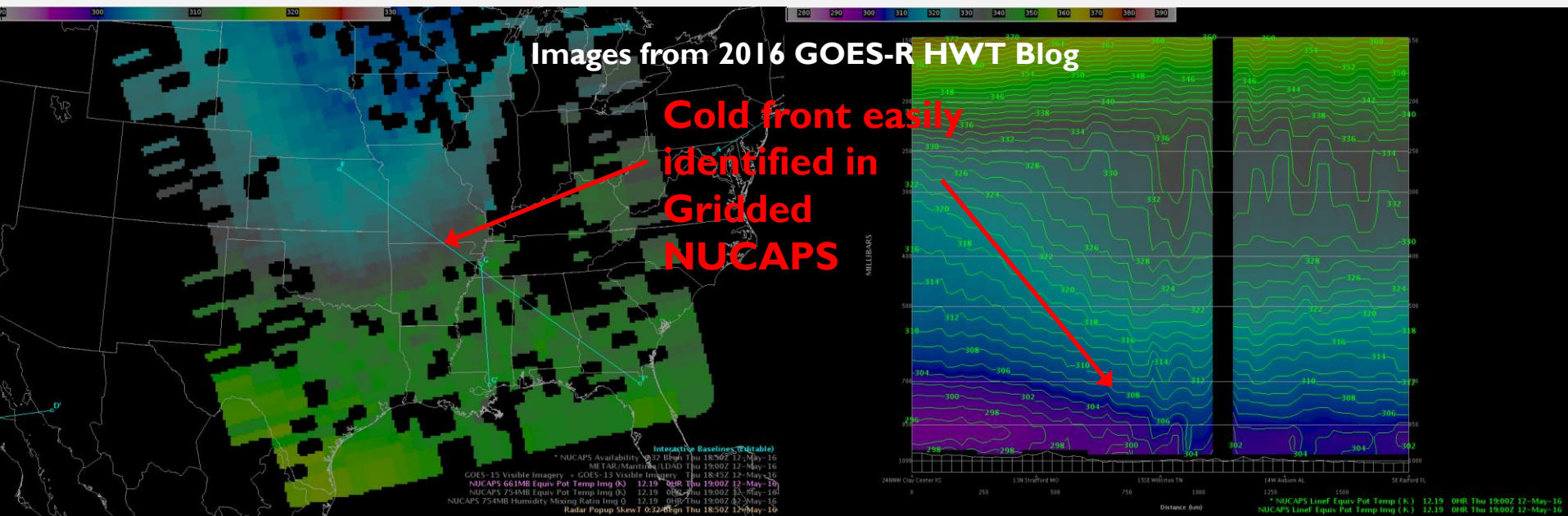
- Forecasters identified several events that occurred during the 2016-2017 evaluation and plan to compare the Gridded NUCAPS to soundings and AMDAR data and present results at AMS
- AGU presentations to highlight Cold Air Aloft and HWT work
- Forecasters requested the Gridded NUCAPS include data on flight levels
- Another Cold Air Aloft demonstration with the CWSU this Winter 2017-2018
- Transition of processing to GINA to reduce product latency





# FORECAST CHALLENGE: PRE-CONVECTIVE ENVIRONMENT

- The vertical distribution of temperature and moisture in the lower atmosphere determines convective potential
- Forecasters use a combination of in situ observations, satellite data, and models to determine the location of boundaries and areas of instability
- Ability to view plan view and cross sections of NUCAPS data were demonstrated at the 2016 and 2017 Hazardous Weather Testbed Experimental Warning Program
- Goal was to assess product utility for another application



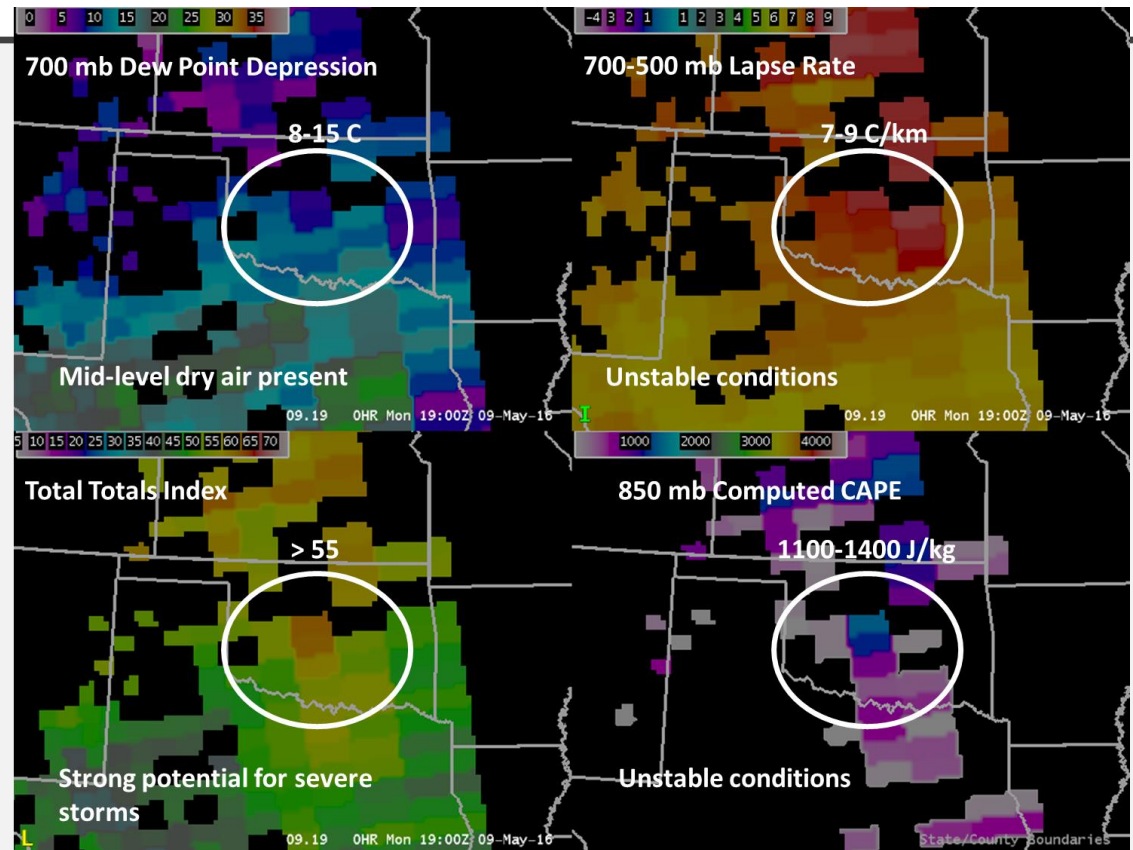
# HWT DEMONSTRATION

- Preparation for HWT:

- CIMSS updated Polar2grid to output all pressure levels and surface variables and mask values below the surface
- Some levels were forced to standard levels to allow AWIPS to calculate stability indices
- Several AWIPS procedures were developed
- More robust training slides and Quick Guide

- During 2017 a wider variety of fields were available in AWIPS:

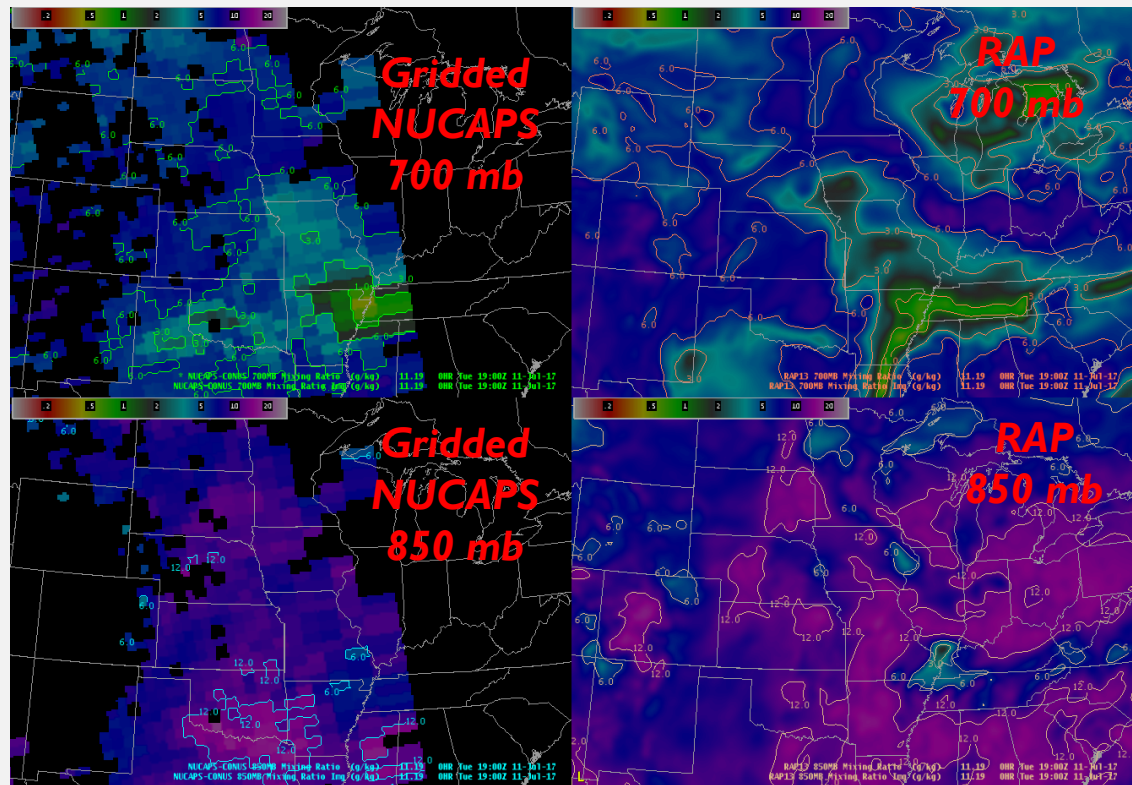
- Temperature, Potential Temperature, Virtual Temperature
- Dewpoint, Dewpoint Depression, Mixing Ratio, Relative Humidity, Theta E, Saturated Theta E, Specific Humidity
- CAPE, CIN, Lapse Rate, Vertical Totals, Total Totals, Showalter Index, K Index, Cross Totals



# FORECASTER FEEDBACK

“At 700 mb (top two panels with NUCAPS on left and RAP on right), it looks like both are generally showing a dry tongue stretching up from Tennessee across Missouri. They are also both in good agreement on the mixing ratios over our new forecast area of FSD. **Overall, very impressed how well NUCAPS matches up with the latest model data at 700mb.**” – HWT forecaster 11 July 2017

“Looking a bit farther lower at 850mb (lower panels), it looks like mixing ratios overall are slightly less than what the RAP is indicating... **Thus, confidence may be a bit better at levels at or above 700mb, but not so good for 850mb or lower.**”



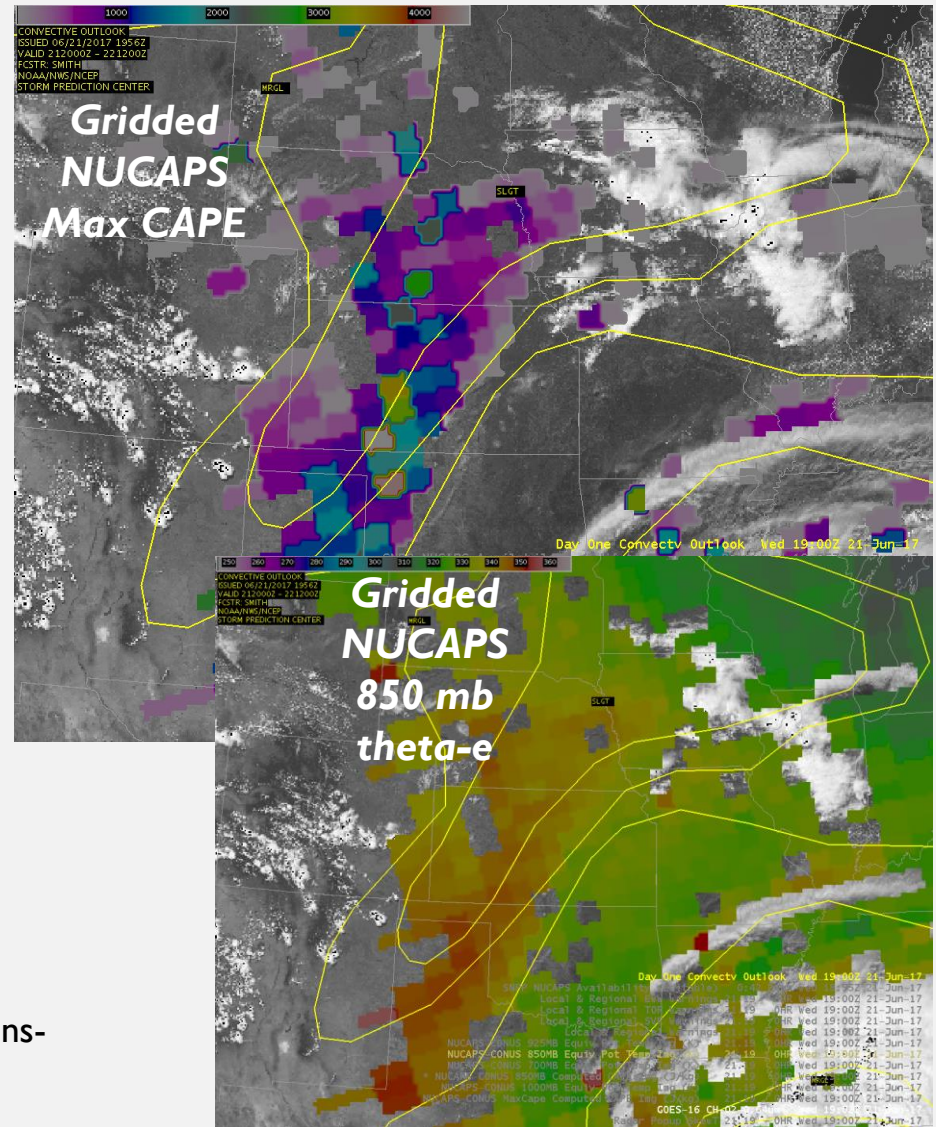


# FORECASTER FEEDBACK

Notice that the axis of max CAPE values is very close but a little to the east of the Slight Risk area, **suggesting perhaps that the better axis of instability lay just to the east of the Slight Risk.** Also, the 850 mb theta-e analysis from the **NUCAPS** gridded data likewise indicated this eastward shift.

**Convection did subsequently develop in western Kansas during the afternoon...** Although data from NUCAPS are a few hours old now, the earlier data indicated sufficient instability to keep convection development ongoing downstream and that increased intensity is possible as it moves into a region of higher instability. - Kris White HWT 2017

<http://goesrhwt.blogspot.com/2017/06/nucaps-observations-in-w-kansas-for-21.html>



# NEXT STEPS

- **“Gridded NUCAPS” enables greater situational awareness by enabling quick and easy visualization of spatial patterns.** Plan views of NUCAPS can be overlaid on imagery such as those from ABI on GOES-16. This product also allows easy comparison with model fields. Despite the success of this 2017 demonstration, there is much to be done to improve the quality of this product in AWIPS.
- Improve availability of derived fields such as freezing level, lapse rate, CAPE
- Simplified menu/list of derived products
- Only product fields on standard levels
- Better consistency in values between soundings and gridded product
- Explore other applications such as winter weather or fire weather
- Provide feedback to AWIPS developers to baseline Gridded NUCAPS and improve visualization in AWIPS



# SUMMARY

- Gridded NUCAPS was developed to allow for 3-D interrogation of the atmosphere and specifically to diagnose areas of Cold Air Aloft
- Data sparse regions such as Alaska now have a reliable data source to diagnose Cold Air Aloft over a vast domain which lacks conventional observations
- Forecasters have provided feedback that Gridded NUCAPS has a positive impact on identifying Cold Air Aloft events and increases confidence when issuing Meteorological Impact Statements
- Gridded NUCAPS was evaluated at HWT to explore its use for diagnosing the pre-convective environment
- Forecasters found utility in spatial patterns and gradients, while specific values were not as valuable, especially at lower levels of the atmosphere.
- More work is necessary to improve derivation and representation of stability indices and provide a more simplistic menu
- Collaborating with AVWIPS developers to baseline Gridded NUCAPS and improve visualization in AVWIPS